IDAHO DEPARTMENT OF FISH AND GAME

Joseph C. Greenley, Director

FEDERAL AID TO FISH AND WILDLIFE RESTORATION

Job Performance Report

Projects F-53-R-12 & 13

LAKE AND RESERVOIR INVESTIGATIONS

Job IV-f. Kamloops Life History Studies in Pend Oreille Lake

by

William Goodnight Regional Fishery Manager
Bruce Reininger
Biological Aide

Job IV-g. Separation of Kamloops Stocks in Pend Oreille Lake by Electrophoresis

by

Richard L. Wallace Associate Professor of Zoology University of Idaho
Arthur W. Rourke Associate Professor of Zoology University of Idaho

Age and Growth Characteristics of Pend Oreille Lake Kamloops

by

Robert Anderson Biologist Washington Water Power Company

January, 1978

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GENERAL INTRODUCTION

Kamloops studies were conducted during 1976 and 1977 at Pend Oreille Lake. The Idaho Department of Fish and Game utilized Dingell-Johnson funds for the majority of their effort in gathering Kamloops life history data (F-53-R-12 and 13, Job IV-f). Washington Water Power Company supplied a biological aide to assist in these studies.

The Department furnished Kamloops scale samples to Bob Anderson (Biologist for Washington Water Power Company) and he conducted the appropriate analysis.

The Department furnished equipment needed for a biochemical study of various groups of Kamloops from Pend Oreille Lake to determine if more than one stock of fish was present (F-53-R-12, Job IV-g). Dr. Richard Wallace and Dr. Arthur
Rourke of the University of Idaho donated time and space to conduct these studies.

Results of these three segments are reported separately but because they are closely related, we have combined them under one cover.

JOB PERFORMANCE REPORT

State of Idaho Name: LAKE AND RESERVOIR INVESTIGATIONS

Project No. F-53-R-12 & 13 Title: Kamloops Life History Studies in Pend Oreille Lake

Job No. IV-f

Period Covered: 1 March 1976 to 28 February 1977

ABSTRACT

During 1976 and 1977 we collected life history data on Kamloops trout in the Pend Oreille Lake drainage. We made trend counts of adult spawners in the major tributaries, snorkeled the tributary streams to evaluate abundance and movement of juvenile Kamloops and radio tagged adult fish to assess the presence of over-wintering in the Clark Fork River.

Lightning Creek appeared to be the most significant spawning tributary on the lake; supporting about the same number of spawning adults as was found in the entire Pack River drainage. We estimated the total lake spawning escapement in 1977 to approximate 200 to 300 Kamloops.

Snorkeling data from the tributary streams showed an initial downstream movement of Kamloops fry from the upper spawning gravels to lower nursery areas. The presence of 1 to 2-year old fish in the lower tributaries, coupled with scale analysis data, indicated that a majority of the Kamloops juveniles reared in the tributaries before migrating to the lake.

Although the radio tagging data was not conclusive, it does indicate that fall-run Kamloops overwintered in the Clark Fork River in preparation for spawning the following spring.

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RECOMMENDATIONS

Continue to monitor Kamloops escapement in trend areas of Lightning Creek (Spring Creek) and the Pack River drainage (North Fork of Grouse Creek).

Continue to preserve the remaining quality Kamloops spawning and rearing habitat by seeking land exchanges such as that which occurred on the North Fork of Grouse Creek between private landholders and the U.S. Forest Service.

Periodically check angler pressure on the Lightning Creek and Pack River drainages to assess the harvest of juvenile Kamloops.

Attempt to locate adult Kamloops in the Clark Fork River in the fall and winter months.

Set up a project to monitor the wild Kamloops program at the Clark Fork Hatchery by: (1) evaluating diets and spacial requirements for obtaining best growth and maximizing fecundity of first generation brood stock, and (2) evaluating survival of hatchery-released Kamloops through differential marking of known size and aged Kamloops and monitoring their return as adults.

OBJECTIVES

To estimate the relative abundance of predatory fish species in Pend Oreille Lake.

To locate major spawning areas in the tributaries of Pend Oreille Lake that are used by Kamloops trout and assess relative abundance of spawning fish.

To assess the presence of overwintering adult Kamloops in the Clark Fork River.

To locate major rearing areas that are utilized by sub-adult Kamloops in the tributaries of Pend Oreille Lake and evaluate the relative abundance of rearing fish.

To assess the size and age composition of sub-adult Kamloops rearing in the tributaries and evaluate age of migration to the lake.

To assess the age composition of adult Kamloops trout in the lake and note evidence of repeat spawning through scale analysis.

INTRODUCTION

Gerrard stock rainbow trout (Kamloops) were introduced into Pend Oreille Lake in the early 1940s. Eggs were obtained from the Gerrard spawning site on the Lardeau River, tributary to Kootenay Lake in British Columbia.

Gerrard stock rainbow are noted for attaining large size and having a voracious appetite for kokanee, their principle diet. Hartman (1969) speculated that physical factors at the Gerrard spawning site (substrate size,

water velocity, male aggression intensified by restricted spawning area) have provided genetic selection pressure enhancing the evolution or retention of large size.

Upon introduction of Kamloops to Pend Oreille Lake, a large population of kokanee enabled them to realize their size potential. First releases of year-ling Kamloops in 1941 resulted in the world's record rainbow being harvested in 1947 (16.8 kg, 37 lb). In 1956, 101 Kamloops were caught which exceeded 9.1 kg (20 lb) and 220 which exceeded 8.4 kg (18.5 lb).

During the past 20 years, heavy reliance has been placed on hatchery brood-stock to maintain the Kamloops fishery. An intensive marking program from 1968-1974 indicated a low contribution of hatchery fish to the trophy catch. This information revealed the dependancy of the fishery on wild reproduction, the need for information regarding the status of wild populations, and the need for different hatchery programs to supplement wild reproduction.

During the early 1960s, a fishery developed in the Clark Fork River during October and November. Average weight of fish caught ranged from 6.8 to 8.2 kg (15-18 lb) and 60-70% of the catch exceeded 6.8 kg (15 lb). The fishery lasted up to 6 weeks annually and yielded up to 220 fish. This fishery was the source of much controversy and disagreement as to why these fish entered the Clark Fork River in the fall. Some individuals felt they were fall spawners, others felt they were overwintering in preparation for spawning in the spring and others felt they were simply feeding on spawning runs of kokanee.

Since 1973, the average size of trophy Kamloops (76.7 cm, 17 in) taken in the lake has declined steadily from nearly 5.4 kg (12 lb) to 3.2 kg (7 lb). This alarming decline in size also aroused additional concern for Kamloops populations and the need to ascertain population status.

TECHNIQUES USED

Downstream Migration

Kray-Meekin traps were used to help determine the age at migration of sub-adult Kamloops from the Pack River and Lightning Creek systems. One trap was placed in the North Fork of Grouse Creek, approximately 46 m (50 yd) upstream from the confluence with Grouse Creek, a tributary of the Pack River (Fig. 1). Two other traps were placed side by side in Spring Creek, approximately 46 m (50 yd) upstream from the confluence with Lightning Creek, and a fourth trap was located in Lightning Creek itself above the mouth of Spring Creek (Fig. 2). All of these locations are known Kamloops spawning areas. The North Fork of Grouse Creek trap was installed on 13 June and removed 9 August 1976. The traps in Spring and Lightning creeks were installed 29 June and removed 30 August 1976. On two occasions, 29 July and 5 August, one of the traps were removed from Spring Creek and placed in Granite Creek to check for migrating Kamloops fry. The trap was checked and removed after approximately 24 hours and replaced in Spring Creek. All traps were fished 24 hours a day and generally checked once a day.

In order to estimate the total number of fish migrating downstream past the 4

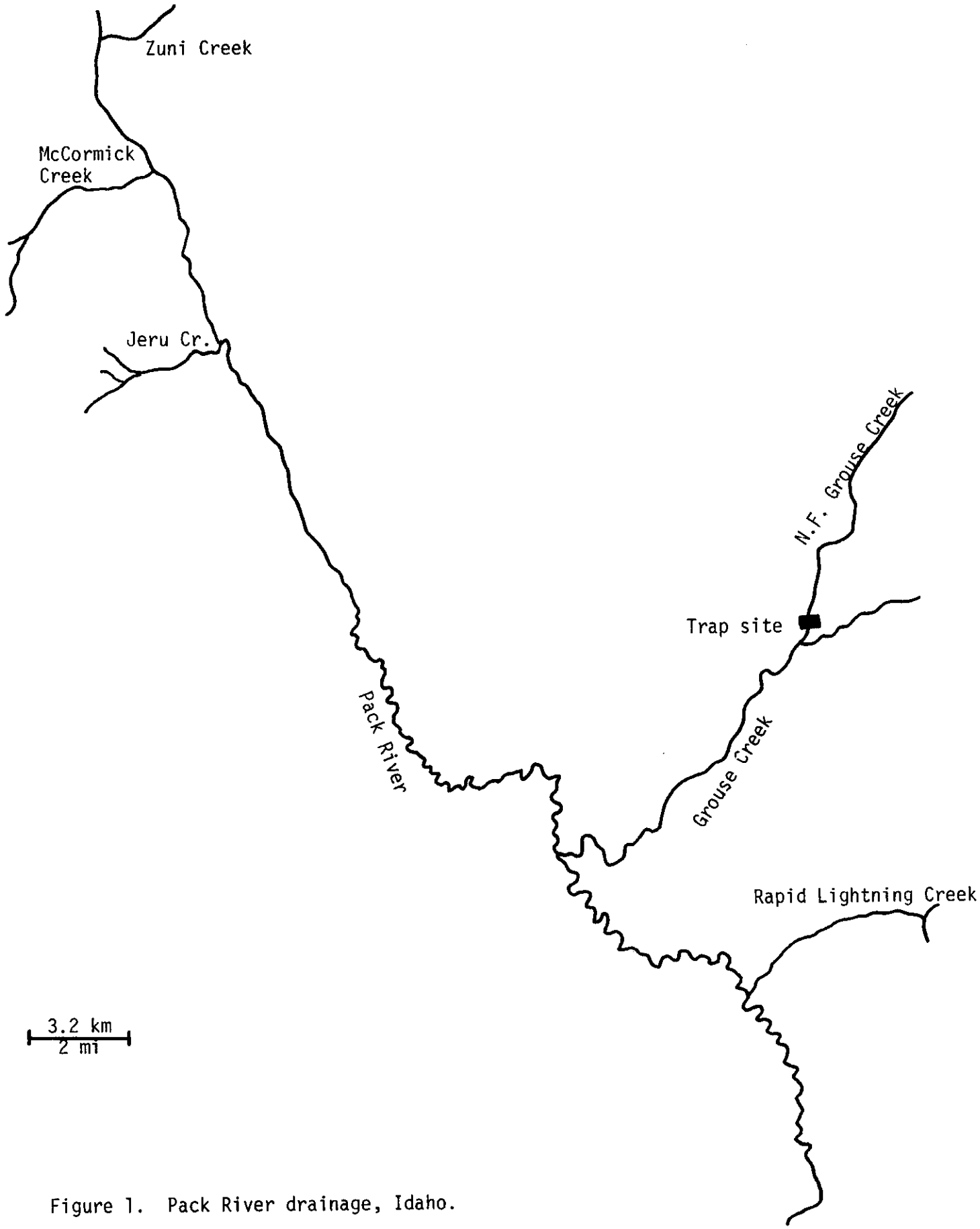

Figure 1. Pack River drainage, Idaho.

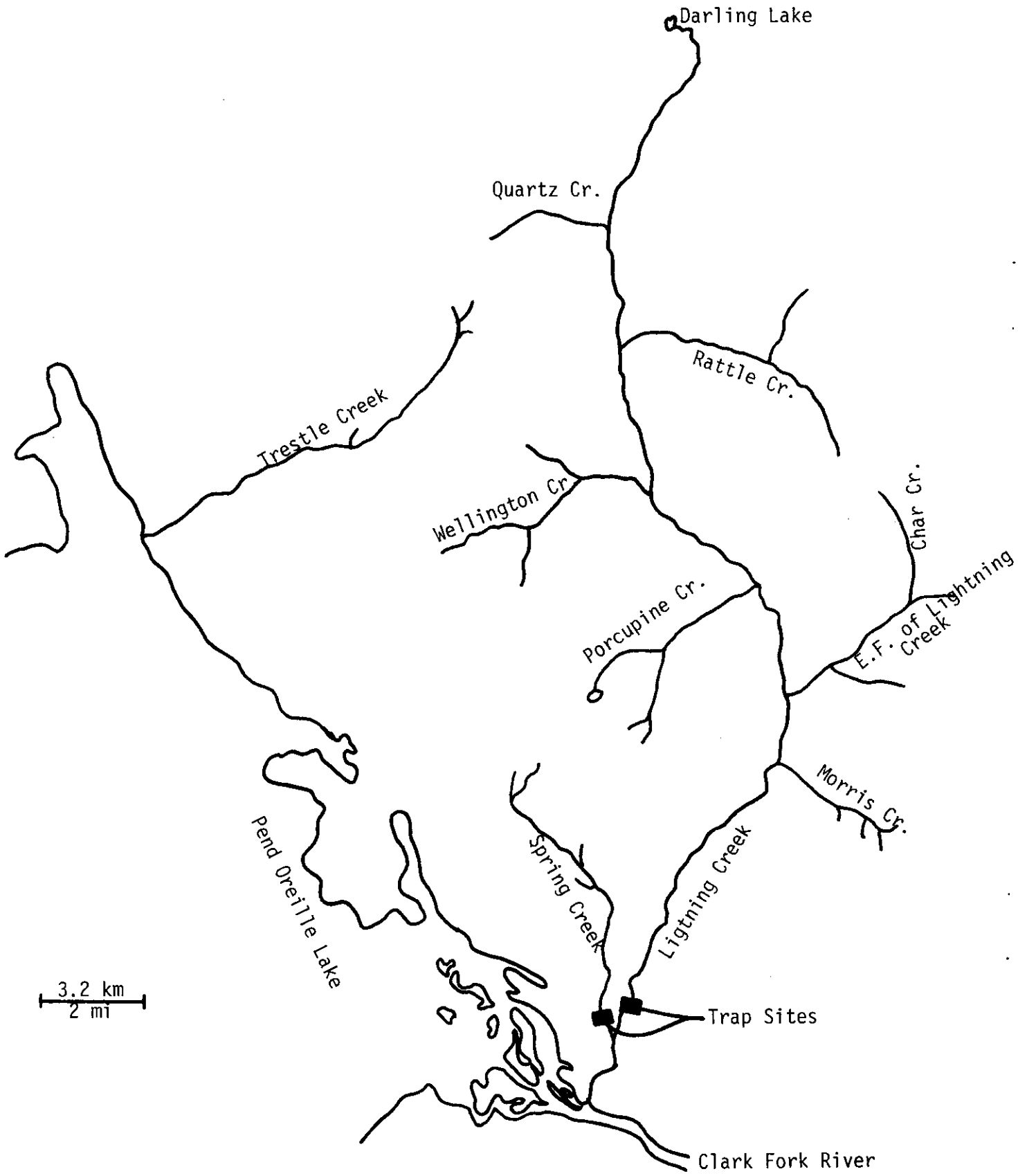

Figure 2. Lightning Creek drainage, Idaho.

traps, a cross sectional area measurement of the trap site was necessary. The stream depth at 30.5 cm (1 ft) intervals across the width of the stream and
flush with the face of the trap were recorded and the cross sectional area calculated. Occasionally, because of fluctuations in stream flow, the traps would have to be relocated within their respective streams so that they were fishing properly. Each time the traps were moved to a new location, a new cross sectional area measurement was taken.

All fish captured in the Kray-Meekin traps were identified as to species and those fish greater than 50 mm (2 in) in length were measured and their lengths recorded. Scale samples were taken from many of the juvenile Kamloops for age determination.

A Moeller thermograph was installed in the North Fork of Grouse Creek, approximately 18.3 m (20 yd) below the culvert on the North Fork, to monitor water temperatures on a 24-hour basis. The thermograph was checked and reset every 7 days and recorded water temperatures from 30 June through 9 August 1976. This information was then compared with daily and hourly fish migrations.

Hourly checks of the North Fork of Grouse Creek trap were made on 19 July and 27 July. The trap was checked each hour starting at 2100 hr and ending at 0500 hr on both occasions. The hourly migrational information was then compared with hourly water temperatures and night light intensity.

Snorkeling

A snorkeling program was initiated to aid in the assessment of the species composition, relative abundance and preferred rearing areas of sub-adult Kamloops in the Pack River and Lightning Creek systems. Several areas in the main channel of Pack River and Lightning Creek were snorkeled, as well as some major tributaries of each which were considered possible Kamloops rearing areas. Those tributaries snorkeled in the Pack River system were Rapid Lightning, Grouse and the North Fork of Grouse creeks (Fig. 1). Those tributaries snorkeled in the Lightning Creek drainage included Spring, Morris, East Fork of Lightning, Porcupine, Wellington, and Rattle creeks (Fig. 2). In each stream several riffles and pools were snorkeled in an attempt to locate all species of fish present in the system and to assess their percent composition and relative abundance. In most cases all fish present were counted, identified as to species (based on morphological characteristics) and their length estimated. In some cases it was not possible to count all the fish present due to either large numbers of fish or the large size of the stream. In these situations species composition was estimated directly. A mean relative abundance could not be accurately calculated as it was for streams in which the total number of fish observed could be counted.

Clark Fork River -- Overwintering Kamloops

During November of 1975 and 1976, we captured adult Kamloops in the Clark Fork River and fitted them with 50 megahertz radio tags (manufactured by the AVM Corporation) in order to determine whether they remained in the river over winter. These tags were 6 cm (2.4 in) long and weighed about 14 g (0.5 oz),
have a range of approximately 0.4 km (1/4 mi) and a life expectancy of 6-7 months. Tags were inserted orally or surgically implanted in Kamloops collected from the

Clark Fork River by hook and line. The locations of tagged fish were monitored by a receiver with the antenna mounted on a vehicle or boat.

We also employed angling on a limited basis during February of 1975 and 1976 to determine whether Kamloops were present in the Clark Fork River. In late December we attempted to use underwater lights to visually observe Kamloops that may have been present in the Clark Fork River.

Spawning Escapement

Foot surveys and snorkeling were used to ascertain utilization of spawning tributaries by adult Kamloops. We snorkeled during mid-summer in order to locate major rearing tributaries and were also able to identify spawning tributiares at this time by the presence of juvenile Kamloops.

During the spring of 1977, we operated weirs on Spring Creek (tributary to Lightning Creek) and Lightning Creek (tributary to the Clark Fork River).

We anticipated being able to maintain trapping facilities in Lightning Creek for only a short period due to onset of high water. We therefore opercle punched all Kamloops passing the Lightning Creek weir. We maintained the Spring Creek weir throughout the run and checked all fish captured at that site for opercle punches. The ratio of punched/unpunched fish observed at Spring Creek provided an indicator of the proportion of the total Lightning Creek run that we trapped and the magnitude of the total run.

FINDINGS

Downstream Migration

The trapping effort in the North Fork of Grouse Creek produced 6,526 Kamloops fry, ranging in size from 25-30 cm (1.0-1.2 in) in the early part of the migration to nearly 50 mm (2 in) toward the end of the migration. From the cross sectional area measurements the estimated total migration from the North Fork of Grouse Creek was 22,388 Kamloops fry. Kamloops fry migration from the North Fork occurred during July (Fig. 3). Also captured in the North Fork of Grouse Creek trap were 10 Kamloops juveniles greater than 50 mm (2 in) in total length (Table 1). No other species of fish was captured in the North Fork trap.

The total number of Kamloops fry captured in Spring Creek was 2,232 for an estimated total migration of 8,680 fry. Kamloop fry moved out of Spring Creek from mid-July through August (Fig. 4). Spring Creek also produced the largest number of fish species greater than 50 mm (2 in) in total length (Table 1).

In Lightning Creek, 24 Kamloops fry were trapped for an estimated total migration of 444 fry. Wild rainbow was the primary species of fish captured in the trap that exceeded 50 mm (2 in) in length and consisted of six individuals (Table 1).

On both occasions that a trap was fished in Granite Creek, a Dolly Varden juvenile was captured but no Kamloops fry were captured or seen.

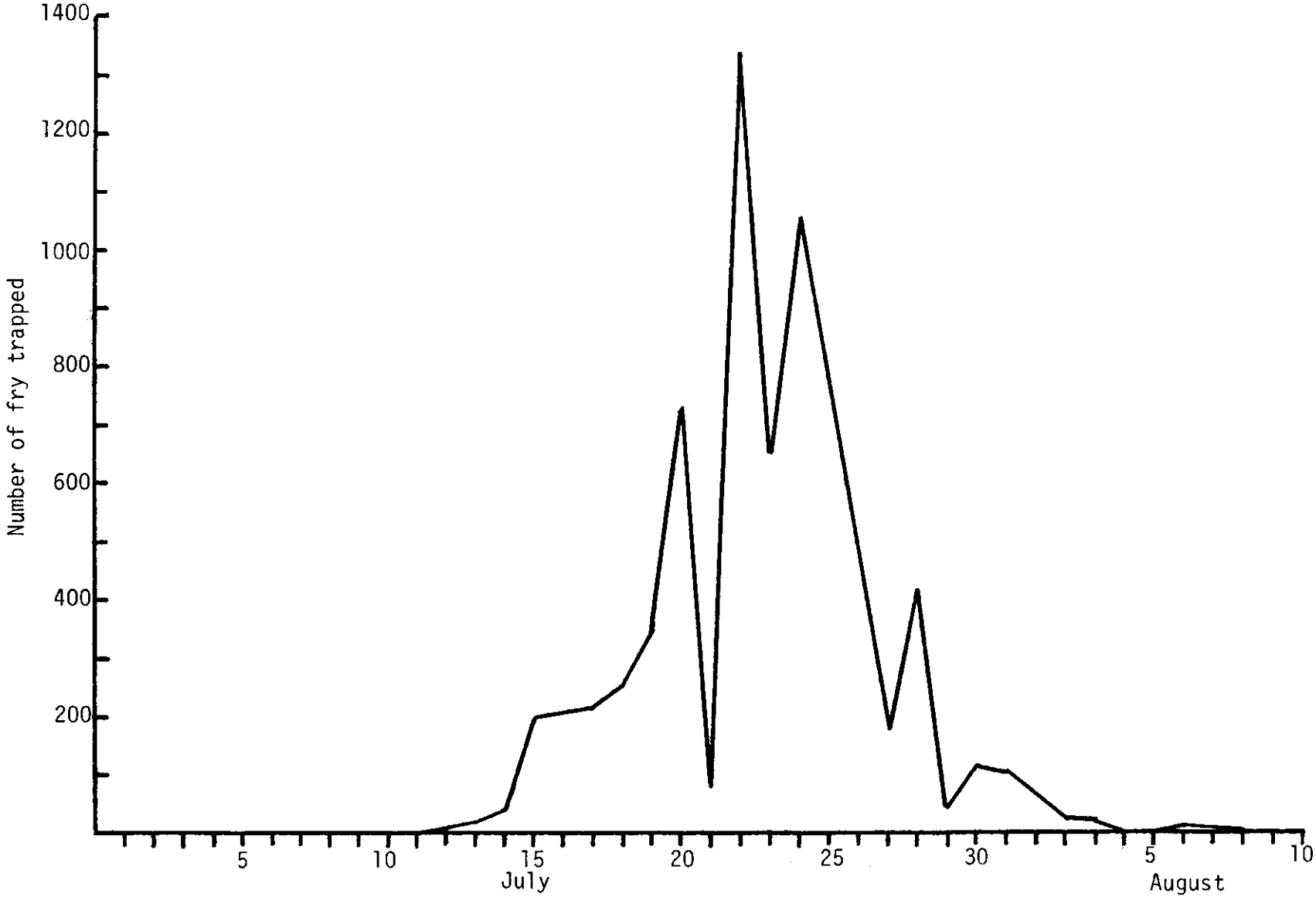

Figure 3. Number of Kamloops fry trapped daily through the North Fork of Grouse Creek trap, 1976.

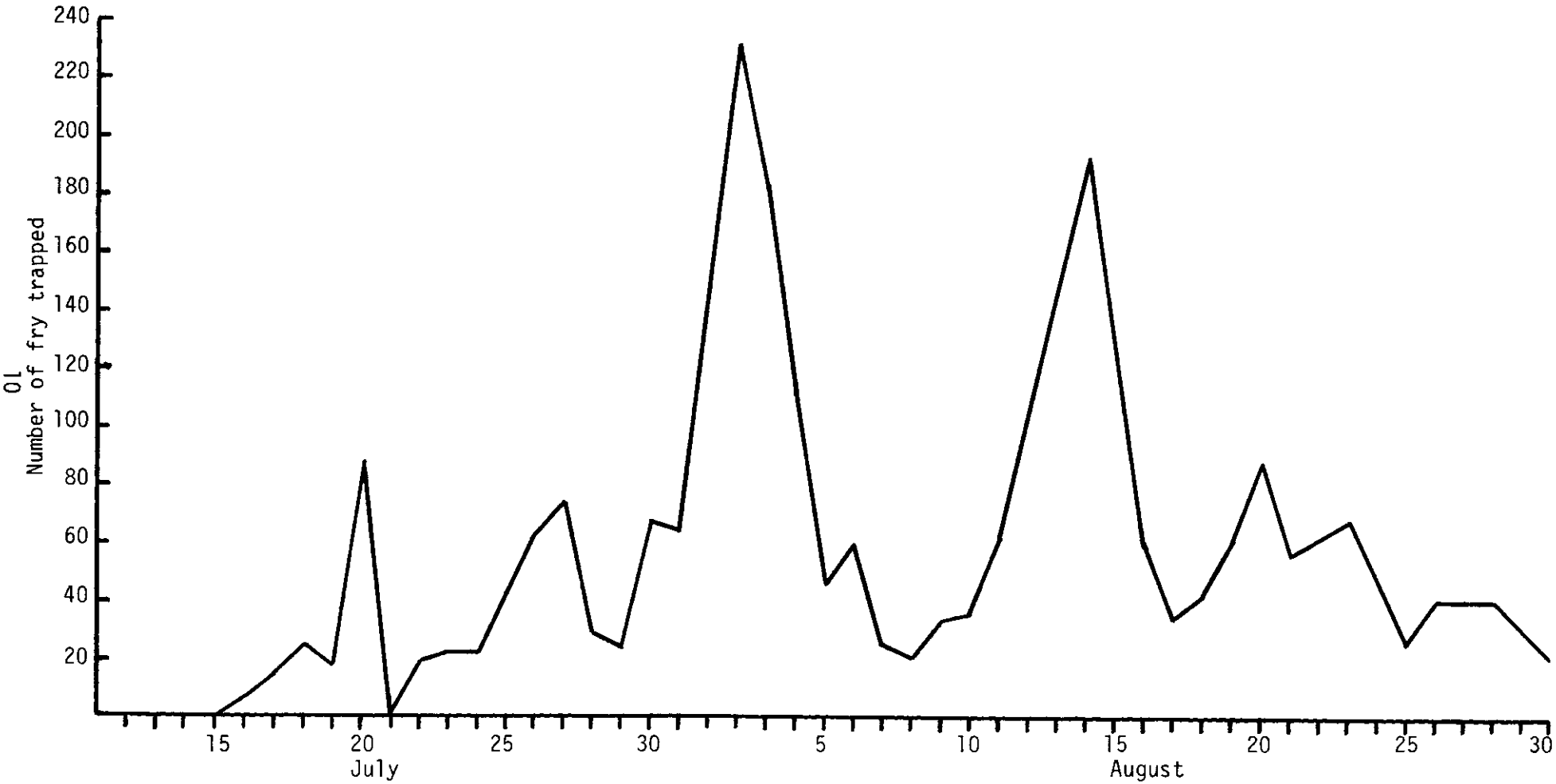

Figure 4. Number of Kamloops fry trapped daily through the Spring Creek trap, 1976.

Table 1. Fish greater than 50 mm (2.0 in) captured in Kray-Meekin traps during summer, 1976.

Species	North Fork Grouse Creek		Spring Creek		Lightning Creek	
	50-100 mm	100 mm +	50-100 mm	100 mm +	50-100 mm	100 mm +
Wild rainbow	5	5	55	21	2	4
Hatchery rainbow	--	--	1	109	--	--
Cutthroat	--	--	24	1	--	--
Brook trout	--	--	1	2	--	--
Dolly Varden	--	--	25	--	--	--
Whitefish	--	--	12	--	--	--
Longnose dace	--	--	1	--	1	--
Sucker	--	--	--	--	1	--

The thermograph installed in the North Fork of Grouse Creek showed water temperatures ranging between a low of 10 C (50 F) and a high of 20 C (68 F) during the period 12 July through 9 August 1976 (Fig. 5). This in-formation coupled with the daily fry movements from the North Fork of Grouse (Fig. 3) indicated that fry movement is not solely dependent upon water temperature. There appeared to be no correlation between daily fry movement and daily water temperature.

The hourly checks of the fry trap in the North Fork of Grouse Creek, on both occasions, showed a peak movement of fry in the period between 2200 hr and 0200 hr. Between these hours, 85% of the night's total of 727 Kamloops fry were trapped on 19 July and 67% of 419 total fry were trapped on 27 July 1976. The peak hourly movement on 19 July occurred between 2200 and 2300 hr with 237 fry being captured. On 27 July the peak hourly movement occurred between the hours of 2300 and 2400 hr, with a total of 110 Kamloops fry being trapped (Fig. 6).

A comparision of hourly fry migrations and hourly water temperature fluctuations showed no evidence of fry migration depending upon water temperature. The hourly fry migrations were also compared with night light intensity. The nights of 19 July and 27 July were both clear, but on 19 July there was a bright half moon occurring on 0030 hr. There was no moon on the night of 27 July. On 19 July only 39% of the night's total fry migration occurred after the moon had risen, however, on 27 July 58% of the night's total fry migration occurred over the same time period when no moon was present.

Rearing

Pack River Drainage

Three areas of the upper Pack River were snorkeled in an attempt to locate juvenile Kamloops rearing areas. Due to the large size of the stream, an accurate count of all fish present in the area snorkeled was not possible; there-fore, a gross observation of the species present was made. In the first area, 46 m (50 yd) above the falls at Zuni Creek for 1.2 km (3/4 mi) downstream, cut-throat was the only species of fish seen. These fish were primarily between 76-152 mm (3-6 in) in estimated length. Approximately 10% of the cutthroat in this area were over 152 mm (6 in).

In the second area, from the bridge below McCormick Creek for 183 m (200 yd) downstream, the predominant fish were again cutthroat between 76-152 mm (3-6 in). One hatchery rainbow of catchable size (254 mm, 10 in) and two juvenile Dolly Varden approximately 152 mm (6 in) each were also observed. In the third area of the upper Pack River, which extended from 1.6 km (1 mi) above the junction of Jeru Creek Road for 183 m (200 yd) downstream, a greater diversity of fish species was present. These included numerous Kamloops or cutthroat fry, numerous wild rainbow between 76-152 mm (3-6 in), a few wild rainbow greater than 152 mm (6 in), a few cutthroat primarily between 76-152 mm (3-6 in), two juvenile Dolly Varden 127-152 mm (5-6 in), and two mountain white-fish approximately 305 mm (12 in). In this area the fry and small rainbow occurred in the highest numbers.

Three areas were also snorkeled in the lower Pack River and were located as

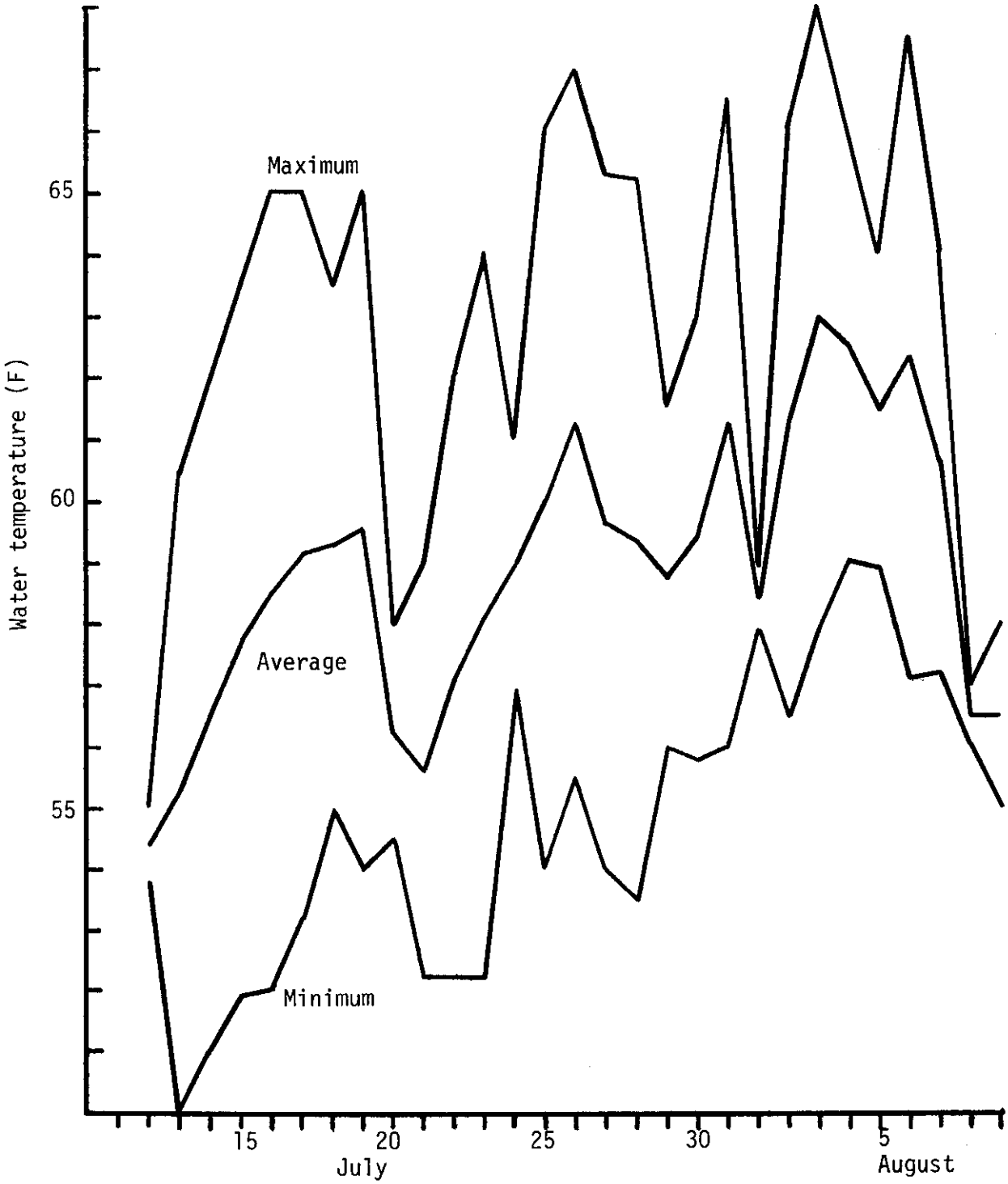

Figure 5. Water temperatures recorded in the North Fork of Grouse Creek during July and August of 1976.

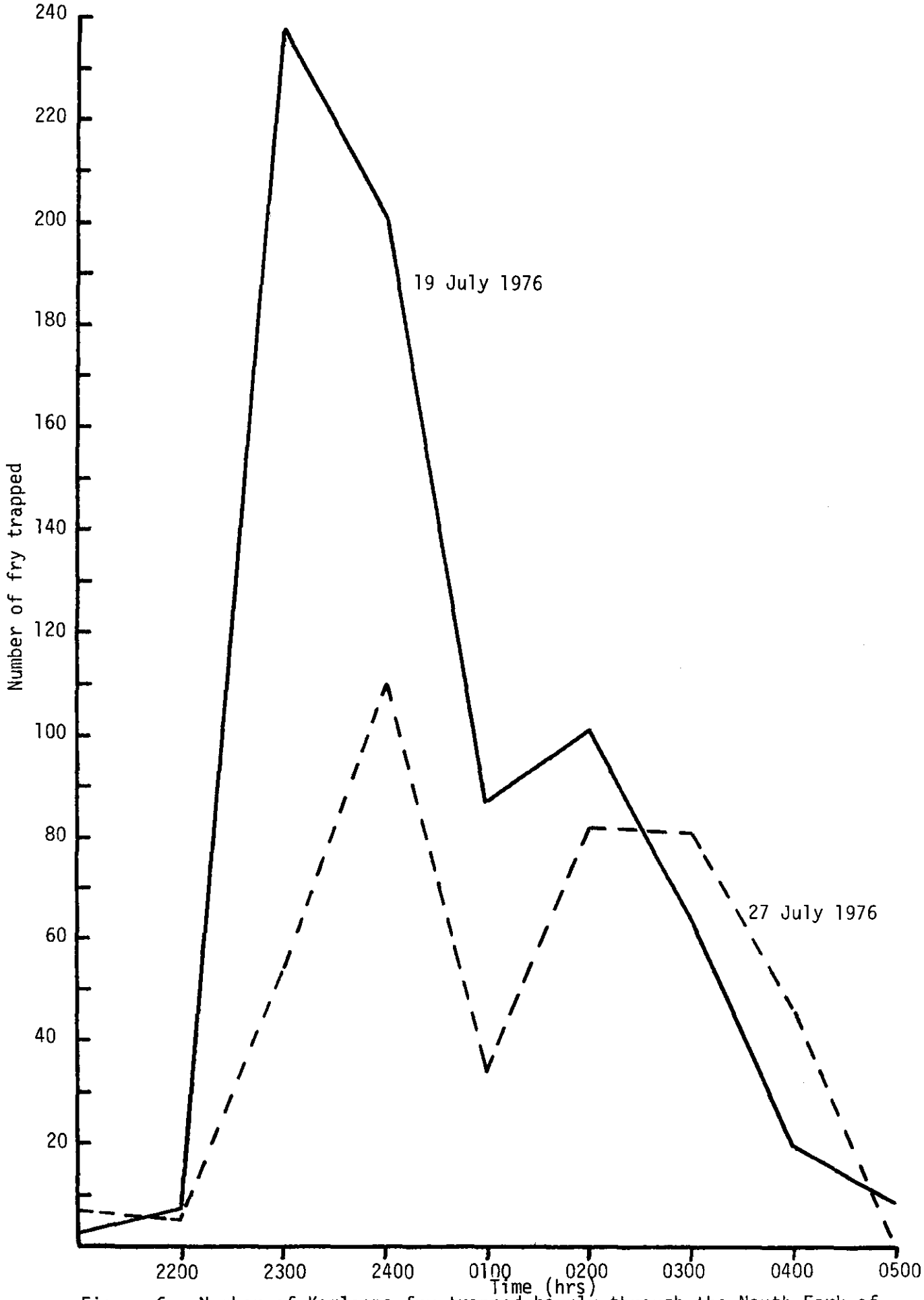

Figure 6. Number of Kamloops fry trapped hourly through the North Fork of Grouse Creek trap, 1976.

follows: (1) from 274 m (300 yd) above the northern most bridge across the Pack River on the Colburn-Culver Road for 1.2 km (3/4 mi) downstream; (2) from 183 m (200 yd) above the southern most bridge across the Pack River on the Colburn-Culver Road for 457 m (500 yd) downstream; (3) from the first bridge upstream from the mouth of Rapid Lightning Creek downstream to the mouth of Rapid Lightning Creek. The fish species most predominant in these sections of lower Pack River were sucker fry, redside shiners about 75 mm (3 in) in length, squawfish 152-305 mm (6-12 in), and mountain whitefish ranging from 152-356 mm (6-14 in) (Table 2). A total of eight wild rainbow were seen in these areas

Rapid Lightning Creek was snorkeled from its mouth upstream approximately 183 m (200 yd). This section of Rapid Lightning Creek contained numerous Kamloops fry, 60 wild rainbow at 76-152 mm (3-6 in), and 12 wild rainbow about 178 mm (7 in), which constituted 70% and 14%, respectively, of the total fish observed. A mean relative abundance of the 76-152 mm (3-6 in) rainbow was calculated as 10 fish per pool and two fish per pool for the 152-305 mm (6-12 in) rainbow (Table 3a).

A total of 20 pools were snorkeled in different areas of Grouse Creek. Five pools were snorkeled approximately 1.6 km (1 mi) above the mouth of the North Fork of Grouse Creek, 10 pools from the confluence of the North Fork to 1.6 km (1 mi) below the gravel pit, and 5 more pools on the south side of the bridge on the Colburn-Culver Road. The primary fish species observed was wild rainbow. Approximately 45% of all the fish seen were wild rainbow between 76-152 mm (3-6 in) and about 10% were rainbow from 152-305 mm (6-12 in) in length. The Kamloops fry present in this area were seen in greater numbers in that portion of Grouse Creek south of the bridge. In this area the fry were too numerous to count. The mean relative abundance of the 76-152 mm (3-6 in) rainbow was calculated at 9.5 fish per pool and 2.0 fish per pool for the 152-305 mm (6-12 in) rainbow (Table 3b).

In the North Fork of Grouse Creek the areas snorkeled were from the culvert on the North Fork downstream to 46 m (50 yd) above the mouth and from the upper subdivision area downstream to the end of the road on the east side of the creek. The primary species of fish present was wild rainbow (43%) in the 152-305 mm (6-12 in) size range. Brook trout were the most numerous at 24% of the observed fish and then wild rainbow from 76-152 mm (3-6 in) at 18%. The mean relative abundance of wild rainbow can only be estimated as the total number of pools snorkeled were not recorded. There appeared to be two or less wild rainbow per pool (Table 3c).

Lightning Creek Drainage

Five different areas were snorkeled in the main Lightning Creek channel (Tables 4a-4e). Due to the large size of Lightning Creek and the large number of fish present, a total count of all fish present was not possible (except in the lowest section) so an accurate mean relative abundance figure could not be calculated. Species composition was estimated directly from those fish actually observed. In the lower regions of Lightning Creek, from Porcupine Creek bridge downstream, there were large numbers of Kamloops fry and a high percentage of wild rainbow from 76-152 mm (3-6 in) and hatchery rainbow of catchable size. In that region of Lightning Creek above Porcupine Creek, the predominant

Table 2. Species composition and relative abundance estimated from 1976 snorkeling program in lower Pack River (main channel). Three sections were snorkeled (n=58).

Species	Fry	76-152 mm (3-6 in)		152-305 mm (6-12 in)		305 mm + (12 in +)	
		TC*	SC*	TC	SC	TC	SC
Wild rainbow	--	4	6.9	4	6.9	--	--
Hatchery rainbow	--	--	--	--	--	--	--
Cutthroat	--	--	--	--	--	--	--
Brook trout	--	--	--	--	--	--	--
Dolly Varden	--	--	--	--	--	--	--
Whitefish	--	--	--	28	48.2	5	8.6
Suckers	TNTC*	--	--	--	--	17	29.3
Redside shiner	--	TNTC	--	--	--	--	--
Squawfish	--	--	--	TNTC	--	--	--

*TC - Total count
*TNTC - Too numerous to count
*SC - Species compostion (%)

Table 3. Species composition and relative abundance estimated from 1976 snorkeling program, Pack River tributaries.

a. Location: Rapid Lightning Creek -- from mouth of Rapid Lightning Creek for 183 m (200 yd) upstream, 6 August 1976. (n=86, 6 pools).

Species	Fry	76-152 mm (3-6 in)			152-305 mm (6-12 in)			305 mm + (12 in +)		
		TC	SC	RB*	TC	SC	RB	TC	SC	RB
Wild raibow	TNTC	60	69.8	10	12	14.0	2	--	--	--
Hatchery rainbow	--	--	--	--	--	--	--	--	--	--
Cutthroat	--	1	1.2	--	1	1.2	--	--	--	--
Brook trout	--	--	--	--	--	--	--	--	--	--
Dolly Varden	--	--	--	--	1	1.1	--	--	--	--
Whitefish	--	--	--	--	5	5.8	--	--	--	--
Suckers	--	--	--	--	--	--	--	2	2.3	--
Squawfish	--	--	--	--	4	4.6	--	--	--	--

TC - total count
*RB - Relative abundance - wild rainbow only
TNTC - too numerous to count
SC - Species composition (%)

Table 3. Species composition and relative abundance estimated from 1976 snorkeling program, Pack River tributaries.

b. Location: Grouse Creek -- see text for description of areas snorkeled, 16 July 1976 and 3 August 1976. (n=371, 20 pools).

Species	Fry	76-152 mm (3-6 in)			152-305 mm (6-12 in)			305 mm + (12 in +)		
		TC	SC	RB	TC	SC	RB	TC	SC	RB
Wild rainbow	TNTC	190	51.2	9.5	41	11.1	2.0	--	--	--
Hatchery rainbow	--	--	--	--	--	--	--	--	--	--
Cutthroat	--	--	--	--	3	.8	--	--	--	--
Brook trout	--	3	.8	--	--	--	--	4	1.1	--
Dolly Varden	--	--	--	--	--	--	--	--	--	--
Whitefish	--	5	1.3	--	28	7.5	--	4	1.1	--
Squawfish	--	--	--	--	17	4.6	--	3	.8	--
Redside shiner	--	73	19.7	--	--	--	--	--	--	--

TC - total count
SC - species composition (%)
RB - relative abundance
TNTC - too numerous to count

Table 3. Species composition and relative abundance estimated from 1976 snorkeling program, Pack River tributaries.

c. Location: North Fork Grouse Creek, 30 June 1976. (n=51, pools*).

Species	Fry		76-152 mm (3-6 in)		152-305 mm (6-12 in)		305 mm + (12 in +)	
	TC	SC	TC	SC	TC	SC	TC	SC
Wild rainbow	--	--	9	17.7	22	43.1	2	3.9
Hatchery rainbow	--	--	--	--	--	--	--	--
Cutthroat	--	--	--	--	--	--	--	--
Brook trout	2	3.9	1	2.0	12	23.5	--	--
Dolly Varden	--	--	--	--	--	--	--	--
Whitefish	--	--	--	--	--	--	3	5.9

*Pools snorkeled not recorded - relative abundance not calculated.
TC - total count
SC - species composition (%)

Table 4. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek.

a. Location: From mouth of Lightning Creek, upstream to 91 m (100 yd) above Lightning Creek bridge, 27 July 1976. (n= 80).

Species	Fry		76-152 mm (3-6 in)		152-305 mm (6-12 in)		305 mm + (12 in +)	
	TC	SC	TC	SC	TC	SC	TC	SC
Wild rainbow	6	7.5	37	46.3	15	18.8	--	--
Hatchery rainbow	--	--	--	--	3	3.7	--	--
Cutthroat	--	--	--	--	5	6.2	--	--
Brook trout	--	--	--	--	--	--	--	--
Dolly Varden	--	--	--	--	--	--	1	1.2
Whitefish	--	--	7	8.8	--	--	6	7.5

TC = total count
TNTC = too numerous to count
SC = species composition (%)

Table 4. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek.

b. Location: From 274 m (300 yd) below mouth of Morris Creek, for 183 m (200 yd) downstream, 18 August 1976.

Species	Fry	76-152 mm (3-6 in) SC *%	152-305 mm (6-12 in) SC %	305 mm + (12 in +) SC %
Wild rainbow	TNTC	50.0	--	--
Hatchery rainbow	--	--	40.0	--
Cutthroat	--	--	5.0	--
Brook trout	--	--	--	--
Dolly Varden	--	--	--	--
Whitefish	--	--	--	5.0

*Total count of fish not made - gross estimation of species composition.
SC - species composition (%)
TNTC - too numerous to count

Table 4. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek.

c. Location: From mouth of East Fork Lightning Creek for 183 m (200 yd) downstream, 17 August 1976.

Species	Fry	76-152 mm (3-6 in) SC %	152-305 mm (6-12 in) SC %	305 mm + (12 in +) SC %
Wild rainbow	TNTC	50.0	--	--
Hatchery rainbow	--	--	30.0	--
Cutthroat	--	--	3.0	--
Brook trout	--	3.0	--	--
Dolly Varden	--	3.0	--	1.0
Whitefish	--	--	--	10.0

TNTC - too numerous to count
SC - species composition (%)

Table 4. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek.

d. Location: From Porcupine Creek bridge downstream to mouth of Porcupine Creek, 17 August 1976.

Species	Fry	76-152 mm (3-6 in) SC %	152-305 mm (6-12 in) SC %	305 mm + (12 in +) SC %
Wild rainbow	TNTC	35.0	--	--
Hatchery rainbow	--	--	60.0	--
Cutthroat	--	--	2.0	--
Brook trout	--	1.0	--	--
Dolly Varden	--	1.0	--	--
Whitefish	--	--	--	1.0

SC - species composition (%)
TNTC - too numerous to count

Table 4. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek.

e. Location: From 183 m (200 yd) above mouth of Wellington Creek to first pool above Char Falls, 15 July 1976. (n=71)

Species	Fry	76-152 mm (3-6 in)		152-305 mm (6-12 in)		305 mm + (12 in +)	
		TC	SC	TC	SC	TC	SC
Wild rainbow	--	3	4.2	--	--	--	--
Hatchery rainbow	--	--	--	9	12.7	--	--
Cutthroat	--	2	2.8	37	52.1	--	--
Brook trout	--	1	1.4	--	--	--	--
Dolly Varden	--	--	--	--	--	19	26.8
Whitefish	--	--	--	--	--	--	--

TC - total count
SC - species composition (%)

species of fish were cutthroat and Dolly Varden. The cutthroat were primarily 152-305 mm (6-12 in) and the Dolly Varden were mature fish ranging from 0.9-6.8 kg (2-15 lb) which had returned to the Lightning Creek system in preparation for spawning in the fall.

In Spring Creek, 18 pools were snorkeled between the mouth of Spring Creek and the Clark Fork Hatchery. Rainbow and Dolly Varden fry were the most abundant, each constituting about 40% of the fish present. Dolly Varden fry were known to be from the hatchery but it was impossible to determine if the rainbow were wild or hatchery stock. An estimated mean relative abundance for Spring Creek is approximately 15 wild rainbow fry per pool. Mountain whitefish was the second most abundant fish species in Spring Creek at 15% of the total population observed (Table 5a).

In Morris Creek (Table 5b) only one wild rainbow, 76-152 mm (3-6 in) was observed in a total of 12 pools snorkeled. The primary fish species in Morris Creek was cutthroat which ranged between 76-152 mm (3-6 in) and comprised 68% of the fish observed.

In the East Fork of Lightning Creek, wild rainbow between 152-305 mm (6-12 in) in length constituted 24% of the total fish seen for a calculated mean relative abundance of 1.2 fish per pool. Cutthroat was the predominant fish species and consisted primarily of fish between 152-305 mm (6-12) (Table 5c). Nine mature Dolly Varden ranging in size from 0.9-5.5 kg (2-12 lb) constituted 11.5% of the observed population.

Twenty-five pools in Procupine Creek were snorkeled near the confluence of the South Fork of Porcupine Creek (Table 5d). In this area the most abundant fish species were Dolly Varden (36%) ranging from 76-152 mm (3-6 in) and cut-throat (32%) also 76-152 mm (3-6 in) in length. Cutthroat between 152 and 305 mm (6-12 in) constituted 15% of the observed fish population. Only one mature Dolly Varden approximately 2.3 kg (5 lb) was observed in the area and there were no wild rainbow seen.

A total count of fish was not made in Wellington Creek, only a gross observation of the species present. Only two species, cutthroat and Dolly Varden, were observed in Wellington Creek. Cutthroat were most abundant and generally ranged from 152-254 mm (6-10 in). One cutthroat exceeding 356 mm (14 in) was observed. There were seven Dolly Varden seen in Wellington Creek, one of which was a 203 mm (8 in) juvenile. The remaining Dolly Varden were mature fish ranging from 0.9-6.8 kg (2-15 lb).

Dolly Varden made up roughly 40% of the total fish seen in Rattle Creek (Table 5e), with 21% of these ranging from 152-330 mm (6-13 in) and 12.5% ranging between 1.4-2.7 kg (3-6 lb). Of the 24 fish observed in 11 pools, 10 of these or about 42% were hatchery rainbow between 254-305 mm (10-12 in) in length. There were no wild rainbow observed in Rattle Creek.

Clark Fork River - Over-wintering Kamloops

Radio Taggin

We collected four Kamloops from the Clark Fork River on 17 and 18 November 1975 by hook and line. These fish ranged from 6.1-11.8 kg (13.5-26.0 lb). All fish were fitted with orally inserted radio tags and immediately released approximately 200 m (219 yd) below the mouth of Lightning Creek.

Table 5. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek tributaries.

a. Location: Spring Creek from 46 m (50 yd) above mouth of Spring Creek to 366 m (400 yd) below fish hatchery, 9 July 1976. (n=670, 18 pools)

Species	Fry			76-152 mm (3-6 in)		152-305 mm (6-12 in)		305 mm + (12 in +)	
	TC	SC	RB	TC	SC	TC	SC	TC	SC
Wild rainbow	270*	40.3	15	--	--	--	--	--	--
Hatchery rainbow	--	--	--	1	.1	--	--	--	--
Cutthroat	--	--	--	--	--	--	--	--	--
Brook trout	--	--	--	1	.1	--	--	--	--
Dolly Varden	270	40.3	15	--	--	--	--	--	--
Whitefish	--	--	--	--	--	100	14.9	26	3.9
Suckers	--	--	--	--	--	--	--	2	.3

*Not sure whether wild or hatchery fish.
TC - total count
RB - relative abundance
SC - species composition (%)

Table 5. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek tributaries.

b. Location: Morris Creek from bridge on Lightning Creek road for 274 m (300 yd) upstream (natural barrier), 18 August 1976. (n=38, 12 pools)

Species	Fry	76-152 mm (3-6 in)			152-305 mm (6-12 in)			305 mm + (12 in +)		
		TC	SC	RB	TC	SC	RB	TC	SC	RB
Wild rainbow	--	1	2.6	.08	--	--	--	--	--	--
Hatchery rainbow	--	--	--	--	6	15.8	--	--	--	--
Cutthroat	--	26	68.5	--	1	2.6	--	--	--	--
Brook trout	--	--	--	--	--	--	--	--	--	--
Dolly Varden	--	3	7.9	--	--	--	--	1	2.6	--
Whitefish	--	--	--	--	--	--	--	--	--	--

TC - total count
RB - relative abundance
SC - species composition (%)

Table 5. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek tributaries.

c. Location: East Fork Lightning Creek - Three areas: (1) from 46 m (50 yd) upstream from mouth 183 m (200 yd) upstream, (2) from second bridge across East Fork for 274 m (300 yd) upstream, (3) from Thunder Creek downstream for 183 m (200 yd), 14 July 1976. (n=78, 16 pools)

Species	Fry	76-152 mm (3-6 in)			152-305 mm (6-12 in)			305 mm + (12 in +)		
		TC	SC	RB	TC	SC	RB	TC	SC	RB
Wild rainbow	--	--	--	--	19	24.4	1.2	--	--	--
Hatchery rainbow	--	--	--	--	4	5.1	--	--	--	--
Cutthroat	--	10	12.8	--	25	32.1	--	--	--	--
Brook trout	--	1	1.3	--	3	3.8	--	--	--	--
Dolly Varden	--	4	5.1	--	3	3.8	--	9	11.6	--

TC = total count
RB = relative abundance
SC = species composition (%)

Table 5. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek tributaries.

d. Location: Porcupine Creek from 183 m (200 yd) upstream from mouth of South Fork of Porcupine Creek (migrational block) for (400 yd) downstream, 17 August 1976. (n=61, 29 pools)

Species	Fry	76-152 mm (3-6 in)		152-305 mm (6-12 in)		305 mm + (12 in +)	
		TC	SC	TC	SC	TC	SC
Wild rainbow	--	--	--	--	--	--	--
Hatchery rainbow	--	--	--	--	--	--	--
Cutthroat	--	20	32.8	9	14.8	--	--
Brook trout	--	5	8.2	2	3.3	--	--
Dolly Varden	--	22	36.0	2	3.3	1	1.6

TC = total count
SC = species composition (%)

Table 5. Species composition and relative abundance estimated from 1976 snorkeling program, Lightning Creek tributaries.

e. Location: Rattle Creek from bridge across Rattle Creek for 0.4 km (1/4 mi) upstream, 15 July 1976. (n=24, 11 pools)

Species	Fry	76-152 mm (3-6 in)		152-305 mm (6-12 in)		305 mm + (12 in +)	
		TC	SC	TC	SC	TC	SC
Wild rainbow	--	--	--	--	--	--	--
Hatchery rainbow	--	--	--	10	41.7	--	--
Cutthroat	--	--	--	4	16.7	--	--
Brook trout	--	--	--	--	--	--	--
Dolly Varden	--	2	8.3	5	20.8	3	12.5

TC = total count
SC = Species composition (%)

On 21 November we located a 7.0 kg (15.5 lb) female and a 11.8 kg (25 lb) male 500 m (547 yd) upstream of the point of release. We were unable at any time to receive a signal from the other two tagged fish.

The location of the tagged male was monitored through December when its location appeared to become stationary directly off the mouth of Lightning Creek. By February it was obvious that we were monitoring the tag that had been regurgitated by the male.

The female's position was located on 13 different dates. On all occasions the fish was located within 500 m (547 yd) of the mouth of Lightning Creek. On 3 May 1975 we received no signal from this fish in the Clark Fork River. On 5 May 1976 this fish was located 14.5 km (9 mi) up Lightning Creek, where we assumed it was spawning.

On 13 April 1976 we fitted two 4.5 kg (10 lb) females with radio tags and released them below the mouth of Lightning Creek. On 25 April 1976 they were both located just off the mouth of Lightning Creek. On 3 May 1976 neither were located in the Clark Fork, and one was located in Lightning Creek about 300 m (328 yd) above the mouth of Spring Creek.

The obvious regurgitation of the radio tag by the 11.3 kg (26 lb) male indicated a probable explanation of our failure to monitor the locations of four of six tagged fish for prolonged periods.

During the fall of 1976 we attempted to improve our methods by surgically implanting the radio tags to avoid regurgitation. We solicited the aid of Dr. Ralph Fruch, D.V.M. to effect surgical incisions, tag insertion and suturing. During the period of 13-20 October 1976 we captured seven Kamloops in the Clark Fork River by hook and line and transferred them to Clark Fork Hatchery. These fish ranged in size from 4.5 to 9.0 kg (10-20 lb). On 21 October, we implanted radio tags in the body cavity of these fish via a 25 mm (1 in) incision on the ventral mid-line, 51 mm (2 in) forward of the insertion of the anal fin. The incisions were closed with sutures and the fish were transported to the Clark Fork River and released immediately upstream from the lower-most bridge, near the town of Clark Fork. Radio tracking indicated all fish began an immediate movement downstream. On 22 October, no tagged fish could be located in the Clark Fork River. One fish returned the following week and remained near the release site through 22 November but could not be located after that date.

Angling and Observation

On 10 February 1976 we angled for Kamloops in the Clark Fork (water temperatures 1.5 C, 35 F) and hooked and played a 4.5 to 6.8 kg (10-15 lb) Kamloops.

On 21 December 1976 we attempted to use underwater lights at night to observe fish in the Clark Fork River. Although visibility was poor, we did observe one 4.5 kg (10 lb) Kamloops.

On 17 January 1977 we observed two 4.5 kg (10 lb) Kamloops approximately 1.6 km (1 mi) below Cabinet Gorge Dam on the Clark Fork River.

Spawning Escapement

1976

During the spring of 1976 we made foot surveys of major Pack River and Lightning Creek tributaries to ascertain use by spawning Kamloops. On 27 April 1976 11 men covered the Lightning Creek drainage, including all potential spawning tributaries below Rattle Creek. United States Forest Service stream habitat surveys were used to establish which tributary reaches were accessible to spawning fish. Twenty-seven Kamloops were observed in Lightning Creek between Cascade and Rattle creeks (19.3 km, 12 mi). Most fish were concentrated in the vicinity of Porcupine Creek. We observed 12 fish in Spring Creek, a lower tributary to Lightning Creek. The only other tributary where we observed Kam-loops was Cascade Creek where we saw one fish. We have documented sightings of spawners in the East Fork of Lightning Creek. We also observed juvenile wild rainbow while snorkeling the East Fork in 1976. No spawners were observed during spawning ground surveys nor juvenile rainbow observed during mid-summer snorkeling of Rattle, Porcupine and Wellington creeks. It appears that, with the exeption of the East Fork and Spring Creek, most spawning occurs in Lightning Creek proper. Lightning Creek and tributaries, at spring flows, afford difficult conditions for visual observation of spawners and this count should be considered a minimum.

With the exception of the North Fork of Grouse Creek, most Pack River tributaries have spring flow conditions which make it difficult to make any quantitative spawning observations. In the past we have documented use of Grouse, North Fork of Grouse and Rapid Lightning creeks by spawning Kamloops. Other Pack River tributaries were walked in the spring of 1976 including Gold, Trout and Caribou creeks. No spawners were observed in these streams.

Spawners were observed in Grouse and Rapid Lightning creeks but water conditions precluded any meaningful counts. Maximum numbers of spawners in the North Fork of Grouse Creek were seen on 20 May when 23 fish were observed.

Although we did not attempt to document Kamloops spawning in main upper Pack River, the number of juvenile rainbow observed during mid-summer snorkeling in the vicinity of Jeru Creek indicates use of the area by spawning Kamloops.

At the time initial Kamloops introductions occurred in Pack River and Lightning Creek tributaries, Hoodoo Creek (tributary to the Pend Oreille River) also received releases. Hoodoo Creek was checked twice during April and May of 1976 and no fish or redds were observed.

Hundreds of thousand of fry, fingerling and catchable-size Kamloops have been released over the past 20 years in Granite Creek, tributary to the east side of Pend Oreille Lake. No Kamloops spawners were observed in 1976. During two 24-hour periods in July and August, Kray-Meekin traps were operated in Granite Creek and no fry were captured.

1977

During the spring of 1977 we operated weirs on lower Lightning and Spring creeks in an attempt to enumerate spawners and to collect eggs for broodstock purposes.

We installed a weir and trap in Lightning Creek and then had to make an extensive evacuation near the stream mouth to make it accessible to Kamloops spawners. The first evening the stream was accessible (5 April), 12 fish ranging from 1.4-7.3 kg (3-16 lb) were passed through the trap. All fish moved after dark and movement coincided with peak flows which occurred after 2100 hr. On 6 April, fish began entering the trap rapidly at 2100 hr. Rising water collapsed the weir after 10 fish were passed. A total of 22 fish were opercle punched and passed through the Lightning Creek trap.

We trapped nine fish in Spring Creek. Two of the nine fish were opercle punched. If we assume that other fish entering Lightning Creek have the same distribution pattern as marked fish, then we can roughly estimate the total Lightning Creek run size to be:

Spring Creek		Lightning Creek
2 (punched)		22 (punched)
9 (trapped)	:	X (total run)

X = 99 fish

The location of the Spring Creek trap was determined for convenience and accessibility by hatchery truck since all fish trapped were transferred to Clark Fork Hatchery for spawning. The trap was located too far upstream to capture the entire run. We snorkeled the stream below the trap on 11 April and observed 20-25 fish. On 19 April, we snorkeled the stream again and observed only five fish and numerous large redds.

Spawning Kamloops were again observed in 1977 in Grouse Creek and Rapid Lightning creek. On 30 April, 37 Kamloops were observed in the North Fork of Grouse Creek.

Broodstock Collection

The apparent failure of our domestic Kamloop broodstock to provide a significant contribution to the trophy fishery stimulated a re-evaluation of hatchery Kamloops programs.

Kamloops are naturally spring spawners (April-May) and attain maturity at 6 years of age. Late maturity is indeed the key to the trophy size potential of these fish. Extended opportunity to feed on kokanee prior to development of sex products facilitates large growth. Hatchery broodstocks had undergone selection for early maturity and calendar year spawning until they were spawning at 3 years of age and from November through January. The decision was made to revert to a wild broodstock which would utilize only fish taken as eggs from wild fish. Wild eggs were collected in 1973 and 1974 and should yield the first egg take in the spring of 1979.

To supplement these two year classes, we decided to capture wild fish via hook-and-line from the Clark Fork River in April, 1976. Between 6-13 April, we collected 32 Kamloops of which 24 (22 females, 2 males) were transferred to the Clark Fork Hatchery. The females averaged 7 kg (15.4 lb) and yielded 125,959 eggs (5,725 eggs/female). Our inability to capture additional males may have

hampered fertilization and egg to fry survival was poor. We released 63,000 resultant fry into Spring Creek and held an additional 10,000 fry for brood-stock.

DISCUSSION

Information gathered from the North Fork of Grouse and Spring Creek traps indicates a definite downstream migration of Kamloops fry. Whether or not these fry are migrating to Pend Oreille Lake during their first summer of life is uncertain. Evidence suggests that this downstream movement may only be a spreading out of over-crowded fry and that the young Kamloops rear for at least 1 year and possibly 2 years in the tributaries of Pend Oreille Lake. J. Irvine (personal communication) found that a majority of the Gerrard rainbow fry emerging in the Lardeau River remained in the river 1 to 2 years before mi-grating to the lake. He found that approximately 10% moved to the lake as fry, likely the result of density factors.

Information collected from the Lightning Creek fry trap, coupled with the snorkeling data, helps to support this idea. Numerous Kamloops fry were observed in the lower regions of Lightning Creek, but very few were captured in the fry trap. It seems logical to assume that if a total fry migration to the lake was occurring, many more would have been captured in the trap and fewer observed above the trap location.

Based on snorkeling information, it appears that there would be a selective advantage for the over-wintering of the young Kamloops for at least 1 year until they are larger before migrating to the lake. High numbers of squawfish were observed in the lower regions of the Pack River downstream from the mouth of Grouse Creek. A Kamloops fry population moving through this area during the low water season (summer) would most likely suffer a high mortality from predation. The same situation exists in the Lightning Creek drainage. The Clark Fork River is known to have a fair population of squawfish which might substantially de-crease a fry population.

The preferred rearing areas of sub-adult Kamloops, as determined from snorkeling in the Lightning Creek system, appears to be restricted to the lower regions of Lightning Creek. The highest concentrations of wild rainbow were found from the Produpine Creek bridge downstream to the mouth of Lightning Creek. The only tributary in this area holding a reasonable population of wild rainbow was the East Fork of Lightning Creek, with a fair population of 152-305 mm (6-12 in) rainbow.

Rearing areas for sub-adult Kamloops in the Pack River system appear to be located in the lower ends of Rapid Lightning and Grouse creeks. That area
of the main Pack River which seems to offer suitable rearing habitat for juvenile Kamloops is that portion of the Pack River lying between Jeru Creek and Highway 95. Upstream from this area the primary fish specie was cutthroat. The portion of the Pack River lying on the east side (downstream) of Highway 95 is heavily laden with sand and silt and offers no rearing habitat at all for juvenile Kamloops.

Kamloops Over-wintering - Clark Fork River

The documented over-wintering of a radio-tagged female in the Clark Fork River is not in itself conclusive proof that all fall-run fish over-winter in the river. However, it does add considerable support to the argument. Other evidence supports this thesis:

1. During the period 1972 to 1975, the fall fishery in the Clark Fork River yielded catches which averaged 6.8-8.2 kg (15-18 lb). The catch clearly consisted of mature, spawning aged fish.

2. The regional files refer to females in the catch being gravid.

3. Fall-run fish have acquired typical rainbow spawning coloration.

4. Scales are tight, difficult to remove, indicating reabsorption--typical of spawning salmonids.

5. Sexual dimorphism is obvious--males have well developed kype.

6. Angling and visual observation verifies presence of Kamloops as late as February.

7. A 11.8 kg (26 lb) male captured in October in the Clark Fork and over-wintered at Clark Fork Hatchery produced sex products in April.

8. There is no other viable explanation for a fall run.

Our failure to monitor other tagged fish may be construed as evidence of their leaving the river. It may also be attributed to tag failure, regurgitation, altered behavior due to stress of handling or mortality due to stress of handling and/or surgery.

We feel the seven fish with surgically implanted tags were definitely stressed so as to alter behavior or cause mortality.

We feel that the fall run of fish in the Clark Fork River are mature, spawning aged fish which are over-wintering in preparation to spawning in Lightning Creek. This is not unusual for rainbow trout populations and particularly for steelhead stocks (from which Kamloops are thought to have derived).

Closure of the fall fishery in 1976 theoretically saved from 66 to 220 spawners (range of past catches). Potential savings are reflected in an apparent 100% increase in spawning escapement in Spring Creek in 1977.

Spawning Escapement

It appears that Lightning Creek is our most significant spawning tributary. 35

The Pack River drainage probably supports an equal number of spawners. On the basis of spawner densities we have seen, we estimate total spawning escapement to be between 200 to 300 fish.

LITERATURE CITED

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AGE AND GROWTH CHARACTERISTICS OF PEND OREILLE LAKE KAMLOOPS

ABSTRACT

Scale samples were collected from Kamloops trout captured in Pend Oreille Lake and tributaries between the years 1972 and 1976. General age and growth characteristics were determined for a total of 537 fish.

Longevity and size are characteristics somewhat unique to the Kamloops found in Pend Oreille Lake. Maturity is generally not reached until the sixth year of life. Multiple repeat spawning is common allowing some individuals to reach an age of 9 years. Late maturity coupled with an abundant food supply of kokanee results in tremendous growth. The largest individuals of the population are normally those fish reaching maturity at age 7. A slower growth rate tends to delay maturity and the additional year of sustained feeding on kokanee produces a highly desirable size of fish. A weight of 9.6 kg (21.1 lb) and length of 852 mm (33.5 in) was found to be average for fish maturing at age 7. Kamloops maturing at age 6 averaged 6.3 kg (14.0 lb) in weight and 774 mm (30.5 in) in length.

Life history information is limited. However, scale interpretation indicates that juvenile Kamloops have migrated from nursery streams to the lake before reaching age 3. Growth is slow within the first 3 years of life, but quickly accelerates when kokanee become the dominant food item in the fourth year of life and at a length of approximately 432 mm (17 in).

The average calculated total lengths in millimeters (inches in parenthesis) for ages 1 through 7 are: 80 (3.2), 143 (5.6), 289 (11.4), 434 (17.1), 625 (24.6), 779 (30.7), and 852 (33.5), respectively. Growth was relatively constant among the years sampled and among year classes. Clark Fork River fish were found to grow generally at the same rate as fish captured in the lake.

The average condition factor for age 5+ and age 6+ Kamloops was found to be 1.42. Condition factors varied but did not decline in the 4-year period of sampling.

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RECOMMENDATIONS

1. Collect scales on an annual basis from Kamloops with special attention to adequately sample all age classes.

2. Through scale interpretation (circulus counts and growth measurements), determine the patternof stream growth in juvenile fish occupying tributary streams and apply this information to adult scales to ascertain the year of stream outmigration.

3. To assess changes in fish robustness, over a long period of time, obtain length and weight data for known age Kamloops and calculate condition factors.

4. Collect otoliths for all age classes of Kamloops to further validate aging through scale interpretation.

OBJECTIVES

1. To assess, by scale interpretation, general age and growth characteristics of Kamloops trout from Pend Oreille Lake.

2. Compare age and growth characteristics of Kamloops among the years sampled: 1972, 1973, 1975 and 1976.

3. Compare age and growth characteristics of Kamloops captured from the Clark Fork River and Pend Oreille Lake.

TECHNIQUES USED

A total of 729 scale samples were collected from Kamloops captured by various means from Pend Oreille Lake and tributaries during the years 1972, 1973, 1975 and 1976. The sports catch in the lake and river was sampled by census clerks while scales were collected from juvenile fish captured in tributaries by use of downstream traps and hook and line. Following the elimination of the Clark Fork River fishery in 1975, scale samples of river fish were collected during spawn-taking and tagging studies.

In 1972 and 1973, only the largest of the trophy-size fish (greater than 432 mm, 17 in, in total length) were sampled in the catch, while in 1975 and 1976, sampling effort was expanded to include all sizes. Data recorded for each fish included total length (inches), weight (pounds), date caught, and location. Scales collected from each fish were from an area located below the dorsal fin and above the lateral line. Two to five good scales were selected for each fish and acetate slide impressions were made of thickness .50 and .75 mm (.02 and .03 in). Impressions were placed in snapshut Kindermann 35mm slide mounts and projected at 60X magnification for analysis using a 35mm slide projector. Age was interpreted, in the manner described by Narver (1968), as the number of annuli located along a radius extending from the focus to the anterior edge of the scale and perpendicular to the posterior sculptured edge. Growth measurements were made along the same radius. All scales of questionable

interpretation were discarded. A total of 537 scale samples were found suitable for interpretation of age, growth, and/or spawning history.

Age and growth data were transferred to IBM cards and a polynominal regression applied to find the best fit for the body-scale relationship. Fish lengths to each annulus were calculated and increments of growth assessed, using the formula, L' = C + (S'/S) (LC), where L is the length of fish at capture, L' is the length of fish at annulus formation, S is the total scale radius length, 5' is the measured distance to a specific annulus, and C is the correction factor for length at scale formation (Rounsefell and Ever-hart 1953). The condition factor (K) was calculated for individual fish, where weight and length were obtained, and no past history of spawning existed (scale interpretation). Condition factors were determined using the formula,

$K = \frac{100,000\ W}{L^3}$, where W is the weight in grams and L is the total length in mm ,Rounsefell and Everhart 1953).

$$TL = 34.41 + 3.1488X + .005107X^2 - .0002157X^3 \quad (x60)$$

where:

TL = Total length in millimeters
X = Scale radius in millimeters x 60

The correlation coefficient equals 0.964

The y-intercept (34.41) of the best fit regression line is used as the correction factor (C) in the direct proportion formula. The value of 34.41 mm is in agreement with the known length at sacle formation of Kamloops (Smith 1955).

General Observations

Scale samples used in this work represented fish of all age classes and taken at all times of the year, except winter. Scale interpretation was difficult, due to three principal factors. First, individual fish may originate from either a hatchery operation or natural spawn. Until recently, thousands of hatchery-produced fry and fingerlings, progeny of domesticated brood stock at Clark Fork Hatchery, were released into Pend Oreille Lake and tributaries. Fish which appeared to be of hatchery origin were difficult to age because scales often exhibited sporadic growth with circuli closely spaced. Designation of annuli was difficult, especially during the first 2 and 3 years of life. Fish of apparent wild origin were typically found to have annuli better defined at all ages, and with wider spacing between circuli. A means to differentiate wild and hatchery stock by scale characteristics was beyond the intent of this work.

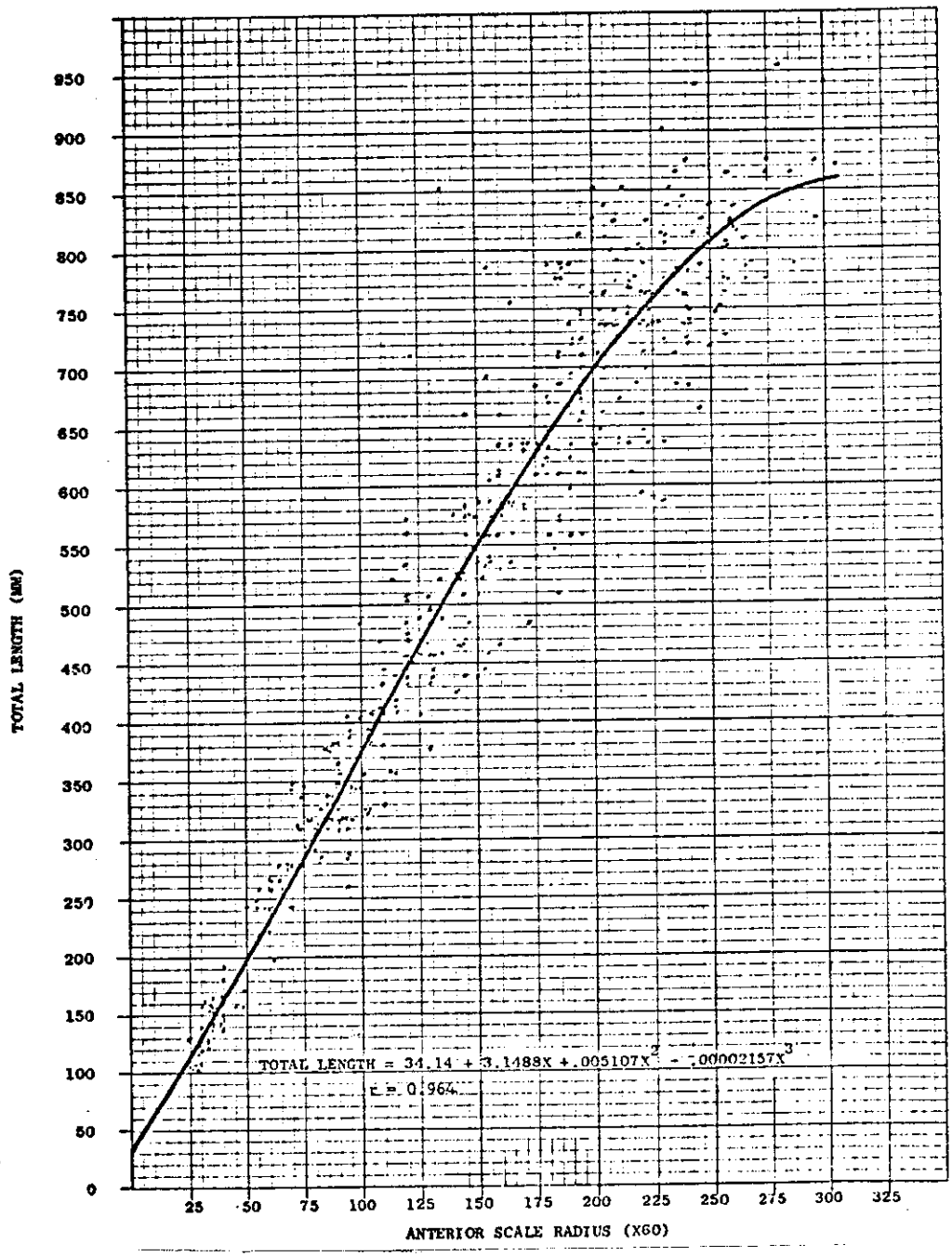

Figure 1. Body-scale relationship of 387 Kamloops rainbow collected from Pend Oreille Lake and tributaries (1972-1976).

Early life history and age designation of hatchery fish, however, may not be significantly changed from that of wild fish, due to the generally small size (0-age) of hatchery releases. Kamloops released as "catchables" did not appear among the catch of trophy size fish. Second, variable periods of nursery stream residence were evident prior to lake immigration. It appears that lake growth (scales exhibiting wide spaces between circuli, indicative of a productive and rich food supply) is present with some fish at all ages. On the other hand, stream growth (narrow and tight spacing of circuli, indicative of slower growth and a more limited food supply) is common for many fish up to and including the second scale annulus but is found rarely following the third annulus. It would thus appear that immigration to the lake occurs predominantly before attainment of age three. Third, the presence of a "false annulus" or "summer check" was found to be very characteristic of scales from Pend Oreille Lake Kamloops. This "false annulus" appears for the first time between the third and fourth year of life and is often as prominent a feature as a winter annulus. The presence of a "false annulus" generally coincides with that area on the scale where Kamloops are considered to make the transition in their diet from zooplankton and terrestrials to kokanee. This may account for the distinctive appearance of the "false annulus". Cartwright (1961) reported on this phenomena in Kootenay Lake rainbow.

Anulus formation of Kamloops in Pend Oreille occurs in late April. Scales collected from fish in the last week of April or first week of May normally exhibited less than three circuli following the annular check.

Growth

Back calculated lengths were determined using the direct proportion formula with the correction factor (Table 1). This method was applied to all fish with scales of reliable interpretation for age and without spawning checks.

Kamloops in Pend Oreille typically exhibit slow growth in length during the first 2 years of life. Following the second annulus, growth rate increases, indicating a possible general shift of juvenile fish from the stream to the lake with its more productive food supply. An even more rapid growth in length is evident late in the third year or early in the fourth year as kokanee become the dominant food item. Growth is typically the most rapid between the fourth and fifth year for those fish reaching maturity at age 6. Growth in length slows in the year preceding maturation. Therefore, if a fish is delayed in reaching maturity until age 7, incremental growth will be greatest between the fifth and sixth year of life (Table 2). The average back calculated total length to each scale annulus for Kamloops from Pend Oreille Lake and tributaries was determined to be 80 mm (3.2 in) at age 1, 143 mm (5.6 in) at age 2, 289 mm (11.4 in) at age 3, 434 mm (17.1 in) at age 4, 625 mm (24.6 in) at age 5, 779 mm (30.7 in) at age 6, and 852 mm (33.5 in) at age 7. Length at age 7 was determined from fish captured in the Clark Fork River on their initial spawning migration and presumably these fish will not increase in length until spawning is completed (Table 2).

Kamloops from the Clark Fork River have consistently averaged larger in length and weight than fish from the lake. A number of theories have been advanced as to the reason for this size variation. One theory postulates that a discrete stock of direct descendants from the original Kootenay Lake (Gerrard

Table 1. Average back calculated total lengths by age class of 387 Pend Oreille Lake Kamloops collected from 1972 through 1976.

Age group	No. of fish	Mean total length at capture	Mean calculated total length in mm (inches in parentheses) to each annulus 1	2	3	4	5	6
I	12	118 (4.7)	78 (3.1)					
II	46	207 (8.2)	78 (3.1)	137 (5.4)				
III	71	352 (13.9)	79 (3.1)	141 (5.6)	291 (11.5)			
IV	95	511 (20.1)	80 (3.2)	143 (5.6)	285 (11.2)	430 (16.9)		
V	123	708 (27.9)	82 (3.2)	145 (5.7)	293 (11.5)	444 (17.5)	634 (25.0)	
VI	40	829 (32.6)	80 (3.2)	143 (5.6)	286 (11.3)	415 (16.3)	596 (23.5)	779 (30.7)
Grand average			80 (3.2)	143 (5.6)	289 (11.4)	434 (17.1)	625 (24.6)	779 (30.7)
Grand average incremental growth			80 (3.2)	63 (2.5)	146 (5.8)	145 (5.7)	191 (7.5)	154 (6.1)
Number of fish			387	375	329	258	163	40

Table 2. Average back calculated total length (mm) and growth increments by sampling year of first time spawning Kamloops from the Clark Fork River.

Year	No. of fish	Age at capture	Annulus 1	2	3	4	5	6*	7*
1972	9	5+	82	152	320	457	665	760	
	2	6+	74	127	307	406	582	811	902
1973	5	5+	85	146	300	466	649	763	
	3	6+	68	122	269	395	568	743	838
1975	1	5+	77	145	263	410	642	749	
	1	6+	67	135	290	385	540	742	813
1976	7	5+	87	159	313	466	682	802	
	4	6+	87	152	313	414	559	752	848
Average	22	5+	84	153	311	460	665	774	
Average growth			69	158	149	205	109		
Average	10	6+	76	136	294	404	564	760	852
Average growth			60	158	110	160	196	92	

*Actual total length when captured in fall or spring assumed length at time of first spawning.

strain) introduction migrate to the river to spawn and these fish have maintained their genetic integrity and a superior growth rate. Another possibility is that only mature fish just prior to spawning enter the Clark Fork River and are caught near the peak of maximum growth and physical condition. In an attempt to answer this question of size differences, growth of lake and river fish is compared by sampling year (Table 3). With the exception of the 1972 lake fish, no signficant differences in back calculated total lengths are apparent among the sampling years. The 1972 lake fish at age 5 and 6 are considerably smaller in length than fish taken from either the river in the same year or from the lake in any of the following years. An explanation for the slower growth is obscure. If a low population level of the kokanee food supply was the cause, then the effect should also be observed in river caught fish. Although the number of kokanee in the lake in 1971 and 1972, as indicated by catch records, was on the decline, the population was considered to be higher than in the years following 1972. Regardless of the slower growth observed in 1972 lake fish, the data indicates that there exists no difference in growth between the lake and river fish. It appears that Kamloops caught in the Clark Fork River are mature fish which make a fall migration prior to spring spawning and are, therefore, not a discrete stock separate from the general lake population.

Scales were collected of juvenile Kamloops from known spawning streams. Table 3 shows the back calculated lengths of juvenile fish sampled in Lightning Creek and the North Fork of Grouse Creek. The average first year growth to a length of 78 mm is comparable to the average first year growth calculated for lake and river fish. However, average incremental growth in the second year was found to be 44 mm to a total length of 122 mm. This is substantially less than the computed average total length to the second annulus calculated for lake and river fish (Table 1). It appears possible with adult fish, using known growth increments of juvenile Kamloops in tributary streams, to determine by scale characteristics the year of stream outmigration.

Age Composition

Age composition of Kamloops indicates that maturity occurs generally at age 6 and with conditions suitable for multiple spawning, the capability does exist for this stock to reach an age of 9 (Table 4). Fish of age 5 and older, numbering 262, account for 62% of the total sample. This is not a representation of population age structure but does point out the longevity factor.

The ages at maturity for 132 trophy size Kamloops with scales showing at least one spawning check and suitable for total age designation are shown in Table 5. Approximately 61% of the sample spawned for the first time at age 6, 18% spawned at age 5, 20% spawned at age 7, and 1% spawned initially at age 4. Scale samples of an additional 18 trophy-size Kamloops could be interpreted for spawning history only, and the cumulative total of 150 repeat spawners represents 29% of the sample of trophy-size fish from the lake, and 59% of the sample of trophy-size fish from the river (Table 6). The proportion of repeat spawners from the catch of Clark Fork River fish varied considerably from a low of 38% in 1973 to a high of 78% in 1975. The proportion of repeat spawners in the lake catch has also varied widely, but this data cannot be considered a true re-presentation due to the fact that only the largest fish were sampled in 1972 and 1973. The higher percentages of repeat spawners in the river catch during

Table 3. Average back calculated lengths (mm) and growth increments by sampling year of Kamloops trout from Pend Oreille Lake and tributaries (1972-1976).

Year	Mean calculated total length (mm) to each annulus (number of fish in parentheses)											
	1		2		3		4		5		6	
Pend Oreille Lake												
1972	82(31)	63	145(31)	142	287(31)	158	445(31)	149	594(31)	112	706(2)	
1973	80(53)	61	141(53)	149	290(53)	162	452(53)	189	641(42)	150	791(14)	
1975	82(113)	63	145(113)	143	288(108)	141	429(50)	209	638(23)	170	808(6)	
1976	81(116)	63	144(116)	146	290(99)	139	429(88)	182	611(43)	170	781(8)	
Clark Fork River												
1972	80(13)	67	147(13)	161	308(13)	137	445(13)	204	649(11)	162	811(2)	
1973	79(10)	57	136(10)	152	288(10)	150	438(10)	180	618(8)	125	743(3)	
1975	72(2)	68	140(2)	137	277(2)	121	398(2)	193	591(2)	151	742(1)	
1976	86(11)	70	156(11)	157	313(11)	134	447(11)	193	640(11)	112	752(4)	
Lightning Creek and North Fork of Grouse Creek												
1976	78(24)	44	122(36)									

Table 4. Age composition of 421 Kamloops from Pend Oreille Lake and Clark Fork River (1972-1976).

Sampling year	Age group	Age designations*																		
		2	3	4		5		6				7			8			9		
				4.S	4	5.S	5	6.S	6.2S	6.3S	6	7.S	7.2S	7.3S	8.2S	8.3S	8.4S	9.3S		
1972					8	2	21	9	5	1	2	6	10	2	2	3	1			
1973			2		11		28	12			14	3	8	2						
1975		5	32		27	1	17	4	4		6	3	4	1	1	1				
1976		17	11	1	45	1	35	20	2		8	8	8	2	2	1	1	1		
Totals		22	45	1	91	4	101	45	11	1	30	20	30	7	5	5	2	1		
Total by age group		22	45		92		105		87				57			12		1		

*Refers to total age and number of spawning checks. As an example, a fish of 7.2S designation has completed 7 years of life and spawned at ages 6 and 7.

Table 5. Age at first spawning of 132 repeat spawning Kamloops from Pend Oreille Lake and Clark Fork River (1972-1976).

Age	Number	Proportion
4	2	1%
5	24	18%
6	80	61%
7	26	20%
Total	132	100%

Table 6. Composition of repeat spawners in sample of trophy size Kamloops (greater than 432 mm, 17 in, total length) from Pend Oreille Lake and Clark Fork River (river fish in parentheses).

Year	Total sample	Total repeat* spawners	Number of spawning checks				Proportion of repeat spawners
1972	75 (28)	42 (15)	15 (8)	18 (5)	8 (2)	1	56% (54%)
1973	80 (16)	22 (6)	12 (5)	7 (1)	3		28% (38%)
1975	43 (18)	4 (14)	3 (5)	1 (8)	 (1)		9% (78%)
1976	124 (34)	25 (22)	15 (12)	6 (7)	4 (2)	 (1)	20% (65%)
Totals	322 (96)	93 (57)	45 (30)	32 (21)	15 (5)	1 (1)	29% (59%)
Grand total	418	150	75	53	20	2	36%

*Includes fish having scales with distinguishable spawning checks but unsuitable for total age interpretation.

1975 and 1976 may indicate a reduced recruitment of first-time spawning fish to the river resulting from an overharvest in the lake of 5, 6, and 7-year old fish or possibly low survival of one or more age classes. On the other hand, these percentages may also indicate a high spawner survival in one or more previous years.

Conditions do appear favorable in Pend Oreille Lake and tributaries for multiple spawning. Scales of 36% of the trophy size fish in the sample have one or more spawning checks. Of the total 150 trophy size fish having scales with spawning checks, 50% exhibit two or more checks and two fish have scales with four distinguishable spawning checks. The overall high proportion of re-peat spawners indicates the importance of spawning survival to the magnitude of the sports catch in the lake and the reproductive potential of the spawning migration in the Clark Fork River.

Length and Weight at Maturity

Length and weight at maturity were determined from Kamloops captured from the Clark Fork River. Fish captured in the fall months were included with spring caught fish due to the fact that the fall caught fish are assumed to be over-wintering in the stream prior to spring spawning and, therefore, no additional growth in length or weight will occur. With this assumption, length and weight at maturity were computed by averaging for those fish determined through scale analysis to be on their first spawning migration (Table 7). Of the fish sampled, Kamloops maturing at age 5 averaged 592 mm (23.3 in) in length and 3.35 kg (7.4 lb) in weight. Mature fish at age 6 averaged 774 mm (30. 5 in) and 6.34 kg (14.0 lb). At age 7, first-time spawners averaged 852 mm (33.5 in) in length and 9. 6 kg (21.1 lb) in weight.

The exceptionally large average size of the age 7 fish naturally raises a question as to what factors may be operating to delay maturity and ultimately result in a more attractive fish to the angler. Rate of growth is often considered a contributing factor. For this reason, back calculated lengths are compared for age 5+ (spawn at age 6) and age 6+ (spawn at age 7) first-time spawners from the Clark Fork River (Table 2). A slower rate of growth is indicated for fish maturing at age 7. At each annulus, fish maturing at age 7 average less in total length than the fish maturing in 6 years. If the 1976 group of fish is excluded, back calculated lengths to the first and second annulus of age 7 maturing fish closely approximate the back calculated lengths for those fish from the North Fork of Grouse Creek and Lightning Creek (Table 3). This may indicate a correlation between residence time in tributary streams and age at maturity. The 1976 group of fish appears to be an exception since growth within the first 3 years of life for maturing at age 6 and 7 is virtually equal. The most significant difference in growth occurs in the period between the third and fifth year of life allowing the age 6 maturing fish to reach an average size at the end of the fifth year of 665 mm (26.2 in) or 101 mm (3.98 in) larger than those fish maturing at age 7. Growth in the year preceeding the initial spawning migration, however, slows considerably, allowing the later maturing fish (age 7) to surpass the earlier maturing fish (age 6) in size and because of the additional year of sustained feeding on kokanee to eventually attain a larger size.

Condition Factor

A decline in the average size of Kamloops in the sport fishery at Pend 49

Table 7. Average weight (kg) and length (mm) of first time spawning Kamloops from the Clark Fork River. Parentheses designate weight in pounds and length in inches.

Year	Age*	Number	Length	Weight
1972	5	2	632 (24.9)	3.30 (7.26)
	6	9	760 (29.9)	6.09 (13.40)
	7	2	902 (35.5)	10.08 (23.80)
1973	5	2	553 (21.8)	3.40 (7.48)
	6	5	763 (30.0)	6.64 (14.61)
	7	3	838 (33.0)	9.97 (21.93)
1975	6	1	749 (29.5)	6.40 (14.08)
	7	1	873 (34.4)	9.10 (20.02)
1976	6	7	802 (31.6)	6.43 (14.15)
	7	4	848 (33.4)	8.80 (19.36)
Average	5	4	592 (23.3)	3.35 (7.36)
	6	22	774 (30.5)	6.34 (13.95)
	7	10	852 (33.5)	9.58 (21.08)

*Age refers to presumed annulus formation at spawning time in spring.

Oreille Lake has been observed over the past few years. Condition factor is an indication of fish " robustness" and is often used to measure physical well-being. A decrease in average size could, therefore, be theoretically indicated in a lower condition factor. Condition factors were calculated for all fish where length, weight, and age information was available. Only those fish with no history of spawning and of age 5+ and age 6+ were used for comparative purposes (Table 8). The average condition factor for all fish used in this analysis was found to be 1.42. The average condition factor for lake fish slightly exceeds that of river fish -- 1.44 vs. 1.38, respectively. River fish of age 5+ caught in 1972 and 1976 have the lowest condition factors while the highest average condition factors are associated with age 6+ river fish. The data indicates that condition factors for 5 and 6 year old Kamloops have varied but not necessarily declined in the period 1972 to 1976. Data collected over a longer period of time is required to provide a more meaningful determination if, in fact, the condition factor of Kamloops in Pend Oreille Lake is declining.

SUMMARY

1. Of 729 scale samples collected between 1972 and 1976 from Kamloops in Pend Oreille Lake and tributaries, samples of 537 fish were found suitable for interpretation of age, growth, and spawning history.

2. Scale interpretation is difficult due to the fact that juvenile fish remain in nursery streams for a variable period of time, fish of hatchery origin are represented in the sample, and there occurs a distinctive "summer annulus" most prominent between the third and fourth year of life.

3. Juvenile Kamloops remain in tributary streams a maximum of 3 years before migrating lakeward. Two years of stream residence appears by scale interpretation to be the most common.

4. Winter annulus formation occurs in late April.

5. Growth is generally slow during the first 2 years of life and accelerates following the second winter annulus. The most rapid growth occurs in the fourth and fifth year of life as kokanee become the dominant food item. Back calculation of total lengths indicates that within the sample age 1 Kamloops averaged 80 mm (3.2 in); age 2, 143 mm (5.6 in); age 3, 289 mm (11.4 in); age 4, 434 mm (17.1 in); age 5, 625 mm (24.6 in); age 6, 779 mm (30.7 in); and, age 7, 852 mm (33.5 in).

6. A comparison of back calculated total length indicates that there were no apparent trends or substantial differences in growth among the years of sampling or among the year classes.

7. A comparison of back calculated total lengths showed no apparent differences in growth between lake and river caught fish. Clark Fork River fish are therefore considered to be mature migrants from the general lake population and not a discrete stock.

8. Age at maturity is generally 6 years. Of the repeat spawners, 61% spawned for the first time at age 6, 18% at age 5, and 20% at age 7. Age 4

Table 8. Condition factors (K) for age 5+ and age 6+ Pend Oreille Lake and Clark Fork River Kamloops.

Year	Age	Number	$\bar{K}$	$\bar{K}$ (Average by year)
		Pend Oreille Lake		
1972	5+	21	1.32	
	6+	2	1.29	1.32
1973	5+	28	1.58	
	6+	14	1.57	1.58
1975	5+	17	1.39	
	6+	6	1.41	1.39
1976	5+	27	1.37	
	6+	8	1.38	1.37
Average		123		1.44
		Clark Fork River		
1972	5+	9	1.20	
	6+	2	1.48	1.25
1973	5+	5	1.51	
	6+	3	1.69	1.58
1975	5+	1	1.51	
	6+	1	1.69	1.60
1976	5+	7	1.23	
	6+	4	1.45	1.31
Average		32		1.38
Grand average		155		1.42

spawners represented only 1% of the sample.

9. Repeat spawners comprised a substantial proportion of the sample of trophy size fish caught in the lake (29%) and of the trophy size fish entering the Clark Fork River (59%). The conditions for multiple repeat spawning in Pend Oreille Lake and tributaries appear favorable as evidence by the fact that 50% of the repeat spawners have scales with two or more spawning checks.

10. The largest individuals of the populations are those fish where maturity is not reached until age 7. Kamloops maturing at 6 years averaged 774 mm (30.5 in) in length and 6.74 kg (14.0 lb) in weight while fish maturing at age 7 averaged 852 mm (33.5 in) in length and 9.58 kg (21.1 lb) in weight. Growth rate appears to be a factor in determining age at maturity as slower growing individuals tend to be delayed in reaching maturity until the seventh year.

11. The average condition factor for all Kamloops in their fifth and sixth year of life with no past history of spawning was found to be 1.42. Condition factors for lake and river fish varied but did not decline in the period of 1972 through 1976.

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JOB PERFORMANCE REPORT

State of Idaho Name: LAKE AND RESERVOIR INVESTIGATIONS

Project No. F-53-R-12 Title: Separation of Kamloops Stocks in Pend Oreille Lake by Electrophoresis

Job No. IV-g

Period Covered: 1 March 1976 to 28 February 1977

ABSTRACT

A biochemical study was conducted from May 1976 to May 1977 to determine if differences in serum proteins were present between two wild populations of Kamloops rainbow trout, Salmo gairdneri, from Pend Oreille Lake, Idaho and the brood stock held at Clark Fork Fish Hatchery.

We could find no consistent differences in serum protein patterns between these populations of trout. Apparently these populations have not been isolated long enough for detectable differences to accumulate.

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INTRODUCTION

There has been a recent increase in concern over the declining fishery for Kamloops rainbow trout, Salmo gairdneri, in Pend Oreille Lake, Idaho. Department biologists have started studies to learn more of the basic biology of these trout and to determine if present management practices are adequate to protect the stocks and improve the sport fishery for this valuable game fish. From May, 1976 to May, 1977, we conducted a biochemical study on various populations of Kamloops trout from Pend Oreille Lake.

OBJECTIVES

1. To characterize blood and muscle protein patterns of various populations of Kamloops trout from Pend Oreille Lake, Idaho.

2. To compare patterns of Kamloops from Pend Oreille Lake with those of hatchery Kamloops trout that have been reared at the Clark Fork Hatchery for a number of generations.

TECHNIQUES USED

Samples were collected from a total of 26 fish at the Clark Fork Fish Hatchery on 13 May 1976. Two wild populations and the hatchery brood stock were available for study. Eight hatchery brood stock (BS) were sampled (Table 1). Eight immature 3 year old fish from the wild population in Spring Creek (SC) and ten mature females from wild Clark Fork fish (CF) were also sampled. The Clark Fork fish were divided into "small" (less than 6.8 kg, 15 lb) and "large" (6.8 kg, 15 lb or more) fish.

Blood samples were taken by syringe from the caudal vein, allowed to clot at ambient temperature for about 20 minutes and stored on ice for 3 to 6 hours. When we returned to the laboratory the samples were centrifuted at 2,000 rpm for 5 to 10 minutes. The supernatent was drawn off and frozen until analyzed. We decided not to take muscle samples because of the possibility of injuring these fish.

We elected to use two-dimensional polyacrylamide gel electrophoresis of serum proteins because of the increased sensitivity of this new technique (Wright, Jr. 1972). Typically electrophoresis is accomplished by passing an electrical current through a medium in an ionized buffer to which the proteins under investigation have been added (Brewer 1970). Because most proteins carry a different net charge, they will migrate at different rates through the medium and become separated. After an appropriate amount of time, the medium can be removed from the apparatus and the separated proteins visualized by staining techniques. Using this technique proteins have been separated by charge in the first dimension of the two-dimensional procedure.

Another way to separate proteins is by size. The pore size of some media, as startch and acrylamide, approaches that of many protein molecules. There-fore, the size and shape of the protein molecule will affect its rate of migration. If a medium can be produced that has a gradient concentration for

Table 1. Populations and sizes of fish sampled at the Clark Fork Hatchery, May, 1976.

Source	Sample size			Length range (cm)	Weight range (kg)
	Males	Females	Total		
Hatchery Brook Stock (BS)	4	4	8	42.0-45.8	0.7-1.2
Spring Creek (SC)	-	-	8	22.2-28.0	--
Clark Fork (CF)					
Small	0	6	6	70.0-76.5	3.6-5.4
Large	0	4	4	77.9-86.6	6.8-8.6

example from 4% to 24% acrylamidae, then separation of proteins can be accomplished both by charge and size of the protein molecules if an electrical current is passed through this gradient gel. This is the basis of the second dimension of two-dimensional polyacrylamide electrophoresis. The end result is a greater separation of proteins and a more powerful biochemical tool for detecting the presence of different protein molecules.

The first dimension gels (4% polyacrylamide) were poured into tubes and allowed to polymerize. From 5 to 15 $_{N}$1 of sera (about 400micrograms of protein) and 5 l of the tracking dye (bromphenol blue) were added to each tube. The amount of sample used was based on Lowry protein determinations (Lowry et. al. 1951) so that total protein of each sample was approximately equalized. A Tris-acetate buffer (pH 8.9) was used throughout these procedures. Fresh buffer was used for every run.

First dimension electrophoresis was carried out by applying an electrical current of 1 ma/tube (DC) for 1 hour (pre-run) and then 10 ma/tube until the dye front migrated off the tubes. An additional 1/2 hour completed the run.

The second dimension polyacrylamide slabs were prepared using an Isolab gel maker and tower. Linear gel gradients of 4-24% acrylamide were routinely used. First dimension gels were removed from the tubes and placed on top of the slabs. Second dimension electrophoresis was carried out by applying 30 ma/tube far 20 hours in an Isolab two-dimensional apparatus. The gels were removed from glass plates, stained with Coomassie Blue in alcohol and acetic acid for about 12 hours and then destained in an alcohol-acetate solution (about 48 hours). Results were recorded on film.

FINDINGS

We could detect no consistent differences between the hatchery brood stock and the wild populations sampled (Fig. 1). No consistent differences were found between " large" and "small" individuals of the Clark Fork population (Fig. 2). Individual variation was detected in the sera analyzed. However, apparently these stocks of fish have not been separated for a long enough period of time for genetic variation between these populations and accumulate to detectable levels using electrophoretic analysis of blood serum proteins.

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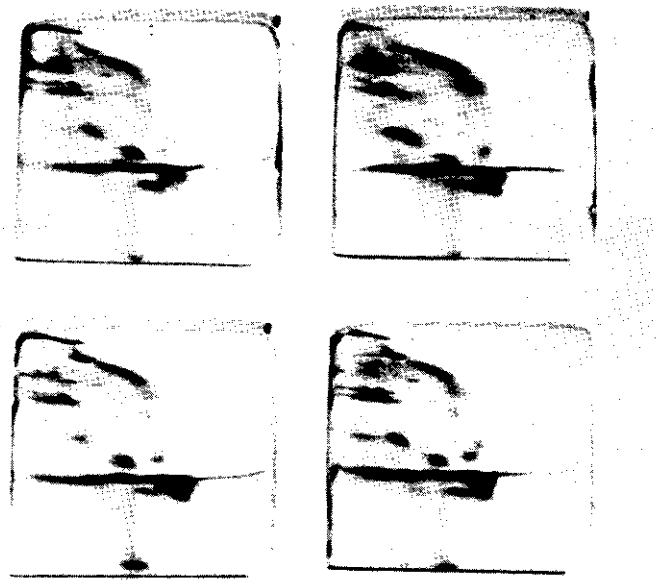

Figure 1. Two-dimensional gels of brood stock fish (upper gels) and Spring Creek fish (lower gels). The upper left gel is from the serum of a female and the upper right gel is from the serum of a male. Sexes could not be determined for the Spring Creek fish by external examination and these fish were not sacrificed.

Figure 2. Two-dimensional gels of sera collected from "large" and "small" Clark Fork fish. The upper pictures are from "large" females and the lower two are from "small" females.

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